EXHIBIT 5

Virtual reality

From Wikipedia, the free encyclopedia
(Redirected from Virtual environment)

Virtual reality (**VR**) is a term that applies to computer-simulated environments that can simulate physical presence in places in the real world, as well as in imaginary worlds. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones. Some advanced, haptic systems now include tactile information, generally known as force feedback, in medical and gaming applications. Furthermore, virtual reality covers remote communication environments which provide virtual presence of users with the concepts of telepresence and telexistence or a virtual artifact (VA) either through the use of standard input devices such as a keyboard and mouse, or through multimodal devices such as a wired glove, the Polhemus, and omnidirectional treadmills. The simulated environment can be similar to the real world in order to create a lifelike experience—for example, in simulations for pilot or combat training—or it can differ significantly from reality, such as in VR games. In practice, it is currently very difficult to create a high-fidelity virtual reality experience, due largely to technical limitations on processing power, image resolution, and communication bandwidth; however, the technology's proponents hope that such limitations will be overcome as processor, imaging, and data communication technologies become more powerful and cost-effective over time.

Virtual reality is often used to describe a wide variety of applications commonly associated with immersive, highly visual, 3D environments. The development of CAD software, graphics hardware acceleration, head mounted displays, database gloves, and miniaturization have helped popularize the notion. In the book *The Metaphysics of Virtual Reality* by Michael R. Heim, seven different concepts of virtual reality are identified: simulation, interaction, artificiality, immersion, telepresence, full-body immersion, and network communication. People often identify VR with head mounted displays and data suits.[*citation needed*]

U.S. Navy personnel using a VR parachute trainer

World Skin (1997), Maurice Benayoun's virtual reality interactive installation

Contents

Background

Terminology and concepts

The term "artificial reality", coined by Myron Krueger, has been in use since the 1970s; however, the origin of the term "virtual reality" can be traced back to the French playwright, poet, actor, and director Antonin Artaud. In his seminal book *The Theatre and Its Double* (1938), Artaud described theatre as "*la réalité virtuelle*", a virtual reality in which, in Erik Davis's words, "characters, objects, and images take on the phantasmagoric force of alchemy's visionary internal dramas".[1] Artaud claimed that the "perpetual allusion to the materials and the principle of the theater found in almost all alchemical books should be understood as the expression of an identity [...] existing between the world in which the characters, images, and in a general way all that constitutes the *virtual reality* of the theater develops, and the purely fictitious and illusory world in which the symbols of alchemy are evolved".[2]

The term has also been used in *The Judas Mandala*, a 1982 science-fiction novel by Damien Broderick, where the context of use is somewhat different from that defined above. The earliest use cited by the Oxford English Dictionary is in a 1987 article titled "*Virtual reality*",[3] but the article is not about VR technology. The concept of virtual reality was popularized in mass media by movies such as *Brainstorm* and *The Lawnmower Man*. The VR research boom of the 1990s was accompanied by the non-fiction book *Virtual Reality* (1991) by Howard Rheingold.[4] The book served to demystify the subject, making it more accessible to less technical researchers and enthusiasts, with an impact similar to that *which his book* The Virtual Community *had on virtual community research lines closely related to VR.*

Multimedia: from Wagner to Virtual Reality, edited by Randall Packer and Ken Jordan and first published in 2001, explores the term and its history from an avant-garde perspective. Philosophical implications of the concept of VR are discussed in books including Philip Zhai's *Get Real: A Philosophical Adventure in Virtual Reality* (1998) and *Digital Sensations: Space, Identity and Embodiment in Virtual Reality* (1999), written by Ken Hillis.

Timeline

Virtual reality can trace its roots to the 1860s, when 360-degree art through panoramic murals began to appear. An example of this would be Baldassare Peruzzi's piece titled, *Sala delle Prospettive*. In the 1920s, vehicle simulators were introduced.[*citation needed*] Morton Heilig wrote in the 1950s of an "Experience Theatre" that could encompass all the senses in an effective manner, thus drawing the viewer into the onscreen activity. He built a prototype of his vision dubbed the Sensorama in 1962, along with five short films to be displayed in it while engaging multiple senses (sight, sound, smell, and touch). Predating digital computing, the Sensorama was a mechanical device, which reportedly still functions today. Around this time, Douglas Englebart uses computer screens as both input and output devices. In 1966, Thomas A. Furness III introduces a visual flight stimulator for the Air Force. In 1968, Ivan Sutherland, with the help of his student Bob Sproull, created what is widely considered to be the first virtual reality and augmented reality (AR) head mounted display (HMD) system. It was primitive both in terms of user interface and realism, and the HMD to be worn by the user was so heavy it had to be suspended from the ceiling. The graphics comprising the virtual environment were simple wireframe model rooms. The formidable appearance of the device inspired its name, The Sword of Damocles. Also notable among the earlier hypermedia and virtual reality systems was the Aspen Movie Map, which was created at MIT in 1977. The program was a crude virtual simulation of Aspen, Colorado in which users could wander the streets in one of three modes: summer, winter, and polygons. The first two were based on photographs—the researchers actually photographed every possible movement through the city's street grid in both seasons—and the third was a basic 3-D model of the city. In the late 1980s, the term "virtual reality" was popularized by Jaron Lanier, one of the modern pioneers of the field. Lanier had founded the company VPL Research in 1985, which developed and built some of the seminal "goggles and gloves" systems of that decade. In 1991, Antonio Medina, a MIT graduate and NASA scientist, designed a virtual reality system to "drive" Mars rovers from Earth in apparent real time despite the substantial delay of Mars-Earth-Mars signals. The system, termed "Computer-Simulated Teleoperation" as published by Rand, is an extension of virtual reality.[5]

Impact

There has been an increase in interest in the potential social impact of new technologies, such as virtual reality. In the book *Infinite Reality: Avatars, Eternal Life, New Worlds, and the Dawn of the Virtual Revolution*, Blascovich and Bailenson review the literature on the psychology and sociology behind life in virtual reality.

In addition, Mychilo S. Cline, in his book *Power, Madness, and Immortality: The Future of Virtual Reality*, argues that virtual reality will lead to a number of important changes in human life and activity.[6] He argues that:

- Virtual reality will be integrated into daily life and activity, and will be used in various human ways. Another such speculation has been written up on how to reach ultimate happiness via virtual reality.[7]
- Techniques will be developed to influence human behavior, interpersonal communication, and cognition.[8]
- As we spend more and more time in virtual space, there will be a gradual "migration to virtual space", resulting in important changes in economics, worldview, and culture.[9]

Heritage and archaeology

The use of VR in heritage and archaeology has potential in museum and visitor centre applications, but its use has been tempered by the difficulty in presenting a "quick to learn" real time experience to numerous people at any given time. Many historic reconstructions tend to be in a pre-rendered format to a shared video display, thus allowing more than one person to view a computer generated world, but limiting the interaction that full-scale VR can provide.[*citation needed*] The first use of a VR presentation in a heritage application was in 1994, when a museum visitor interpretation provided an interactive "walk-through" of a 3D reconstruction of Dudley Castle in England as it was in 1550. This consisted of a computer controlled laserdisc-based system designed by British based engineer Colin Johnson. The system was featured in a conference held by the British Museum in November 1994, and in the subsequent technical paper, *Imaging the Past - Electronic Imaging and Computer Graphics in Museums and Archaeology*.[*citation needed*]

VR reconstruction

Virtual reality enables heritage sites to be recreated extremely accurately, so that the recreations can be published in various media.[10] The original sites are often inaccessible to the public, or may even no longer exist.[*citation needed*] This technology can be used to develop virtual replicas of caves, natural environment, old towns, monuments, sculptures and archaeological elements.[11]

Fiction

Many science fiction books and films have imagined characters being "trapped in virtual reality".

A comprehensive and specific fictional model for virtual reality was published in 1935 in the short story Pygmalion's Spectacles by Stanley G. Weinbaum. In the story, the main character, Dan Burke, meets an elfin professor, Albert Ludwig, who has invented a pair of goggles which enable "a movie that gives one sight and sound [...] taste, smell, and touch. [...] You are in the story, you speak to the shadows (characters) and they reply, and instead of being on a screen, the story is all about you, and you are in it." A more modern work to use this idea was Daniel F. Galouye's novel Simulacron-3, which was made into a German teleplay titled *Welt am Draht* ("World on a Wire") in 1973. Other science fiction books have promoted the idea of virtual reality as a partial, but not total, substitution for the misery of reality, or have touted it as a method for creating breathtaking virtual worlds in which one may escape from Earth.

Stanisław Lem wrote a short story in early 1960 called "IJON TICHY'S MEMORIES", in which he presented a scientist who devised a completely artificial virtual reality. Among the beings trapped inside his created virtual world, there is also a scientist, who also devised such machines creating another level of virtual world.[*citation needed*] Lem further explored the implications of what he termed "phantomatics" in his nonfictional 1964 treatise *Summa Technologiae*. The Piers Anthony novel *Killobyte* follows the story of a paralyzed cop trapped in a virtual reality game by a hacker, whom he must stop to save a fellow trapped player slowly succumbing to insulin shock. This novel toys with the idea of both the potential positive therapeutic uses, such as allowing the paralyzed to experience the illusion of movement while stimulating unused muscles, as well as virtual realities' dangers. Vernor Vinge's *True Names*, published in 1981, imagines a virtual world which is probably the first to represent a metaverse. In the story, characters interact with each other in a complete world, where they own homes and are represented using avatars. This type of virtual world was later to be realized as Second Life, which was launched in 2003.[*citation needed*]

Other popular fictional works that use the concept of virtual reality include William Gibson's *Neuromancer* which defined the concept of cyberspace, Neal Stephenson's *Snow Crash*, in which he made extensive reference to the term avatar to describe one's representation in a virtual world, and Rudy Rucker's *The Hacker and the Ants*, in which programmer Jerzy Rugby uses VR for robot design and testing.

The *Doctor Who* serial "The Deadly Assassin", first broadcast in 1976, introduced a dream-like computer-generated reality, known as the Matrix.

The first major American television series to showcase virtual reality regularly was *Star Trek: The Next Generation*. Several episodes featured a holodeck, a virtual reality facility that enabled its users to recreate and experience anything they wanted. One difference from current virtual reality technology, however, was that replicators, force fields, holograms, and transporters were used to actually recreate and place objects in the holodeck, rather than illusions.

The New Zealand post-apocalyptic soap opera *The Tribe* shows Virtual Reality being used by an advanced enemy tribe named the Technos.

British BBC2 sci-fi series *Red Dwarf* featured a virtual reality game titled "Better Than Life", in which the main characters had spent many years connected. Virtual reality has also been featured in other Red Dwarf episodes, including "Back to Reality", where venom from the despair squid caused the characters to believe that all of their experiences on Red Dwarf had been part of a VR simulation. Other episodes that feature virtual reality include "Gunmen of the Apocalypse", "Stoke Me a Clipper", "Blue", "Beyond a Joke", and "Back in the Red".[*citation needed*]

The popular .hack multimedia franchise is based on a virtual reality MMORPG dubbed "The World" The French animated series *Code Lyoko* is based on the virtual world of *Lyoko* and the Internet. The virtual world is accessed by large scanners which use an atomic process, and breaks down the atoms of the person inside, digitizes them, and recreates an incarnation on *Lyoko*. The Saban show *VR Troopers* also made use of the concept.

There is also Sword Art Online(ソードアート・オンライン, Sōdoāto Onrain), a light novel series written by Reki Kawahara; it is about 10,000 people being trapped in a game world where in the game would mean an actual "death" in real life and the only way to escape is to complete the game.

Moonlight Sculptor by Nam-Hi-Sung is a Korean light novel about the adventures of "Weed" in a virtual reality game called Royal Road.

Motion pictures

- Steven Lisberger's 1982 film *Tron* explored the idea of virtual reality; transporting real-life characters into an alternate, computer-generated world.[*citation needed*]
- One year later in 1983, the Natalie Wood / Christopher Walken film *Brainstorm* revolved around the production, use, and misuse of a VR device. The device could record a person's feelings and experiences, and share these with anyone else.
- A VR-like system, used to record and play back dreams, figures centrally in Wim Wenders' 1991 film *Until the End of the World*.
- The 1992 film *The Lawnmower Man* (which bore little resemblance to the Stephen King story on which it was ostensibly based) tells the tale of a research scientist who uses a VR system to jumpstart the mental and physical development of his mentally handicapped gardener.
- The 1993 film *Arcade* is centered around a new virtual reality game (from which the film gets its name) that actively traps those who play it inside its world.
- Outside the genre of science fiction, 1994's *Disclosure*, starring Michael Douglas (based on the Michael Crichton's novel) depicts a VR headset being used as a navigation device for a prototype computer file system.
- Plot of *The Thirteenth Floor* (1999) is based on two virtual reality simulations, one in another.
- In 1999, *The Matrix* and later sequels explored the possibility that our world is actually a vast Virtual Reality (or more precisely, Simulated Reality) created by artificially intelligent machines.
- The 2001 Mamoru Oshii movie "Avalon" (アヴァロン) is set in a bleak future, where the population is hooked on an immersive illegal virtual reality video game called Avalon. Despite its popularity the game can be deadly, leaving players' bodies catatonic in the real world. One player of the game, Ash (played by Polish actress Małgorzata Foremniak), hears of a secret level hidden within Avalon. The film follows her quest to find the level.
- Ryan Chester's *Virtually Reality (2011)* depicts a future world in which most natural wonders have been destroyed and developed upon, and virtual reality systems provide the only way for humans to experience the nature they never knew for real.

Radio

In 2009, British digital radio station BBC Radio 7 broadcast *Planet B*, a science-fiction drama set in a virtual world. *Planet B* was the largest ever commission for an original drama programme.[12]

Fine art

David Em was the first fine artist to create navigable virtual worlds in the 1970s. His early work was done on mainframes at III, JPL, and Caltech. Jeffrey Shaw explored the potential of VR in fine arts with early works like *Legible City* (1989), *Virtual Museum* (1991), and *Golden Calf* (1994). Canadian artist Char Davies created immersive VR art pieces *Osmose* (1995) and *Ephémère* (1998). Maurice Benayoun's work introduced metaphorical, philosophical or political content, combining VR, network, generation and intelligent agents, in works like *Is God Flat* (1994), *The Tunnel under the Atlantic* (1995), and *World Skin* (1997). Other pioneering artists working in VR have include Luc Courchesne, Rita Addison, Knowbotic Research, Rebecca Allen, Perry Hoberman, Jacki Morie, Margaret Dolinsky and Brenda Laurel. All mentioned artists are documented in the Database of Virtual Art.[*citation needed*]

Music

Immersive virtual musical instruments build on the trend in electronic musical instruments to develop new ways to control sound and perform music such as evidenced by conferences like NIME and aim to represent musical events and sound parameters in a virtual reality in such a way that they can be perceived not only through auditory feedback, but also visually in 3D and possibly through tactile as well as haptic feedback, allowing the development of novel interaction metaphors beyond manipulation such as prehension.

Therapeutic uses

Main article: Virtual reality therapy

The primary use of VR in a therapeutic role is its application to various forms of exposure therapy, ranging from phobia treatments to newer approaches to treating PTSD. A very basic VR simulation with simple sight and sound models has been shown to be invaluable in phobia treatment, like zoophobia, and acrophobia, as a step between basic exposure therapy such as the use of simulacra and true exposure. A much more recent application is being piloted by the U.S. Navy to use a much more complex simulation to immerse veterans suffering from PTSD in simulations of urban combat settings. Much as in phobia treatment, exposure to the subject of the trauma or fear leads to desensitization, and a significant reduction in symptoms.[13][14]

Other research fields in which the use of virtual reality is being explored are physical medicine, rehabilitation, physical therapy, and occupational therapy. In adult rehabilitation, a variety of virtual reality applications are currently being evaluated within upper and lower limb motor rehabilitation for individuals recovering from stroke or spinal cord injury. In pediatrics, the use of virtual reality is being evaluated to promote movement abilities, navigational abilities, or social skills in children with cerebral palsy, acquired brain injury, or other disabilities.[*citation needed*] Research evidence is emerging rapidly in the field of virtual reality for therapeutic uses. A number of recent reviews published in peer-reviewed journals have summarized the current evidence for the use of Virtual Reality within pediatric and adult rehabilitation. One such review concluded that the field is potentially promising.[15]

Implementation

To develop a real time virtual environment, a computer graphics library can be used as embedded resource coupled with a common programming language, such as C++, Perl, Java, or Python. Some of the most popular computer graphic libraries are OpenGL, Direct3D, Java3D, and VRML, and their use are directly influenced by the system demands in terms of performance, program purpose, and hardware platform. The use of multithreading can also accelerate 3D performance and enable cluster computing with multi-user interactivity.

Manufacturing

Virtual reality can serve to new product design, helping as an ancillary tool for engineering in manufacturing processes, new product prototypes, and simulation. Among other examples, Electronic Design Automation, CAD, Finite Element Analysis, and Computer Aided Manufacturing are widely utilized programs.[*citation needed*] The use of Stereolithography and 3D printing shows how computer graphic modeling can be applied to create physical parts of real objects used in naval,[16] aerospace,[17] and automotive industries,[18] which can be seen, for example, in the VR laboratory of VW in Mladá Boleslav. Beyond modeling assembly parts, 3D computer graphics techniques are currently used in the research and development of medical devices for therapies,[19][20][21] treatments,[22] patient monitoring,[23] and early diagnoses[24] of complex diseases.

Urban design

3D virtual reality is becoming widely used for urban regeneration and planning and transport projects.[25]

Pioneers and notables

- Maurice Benayoun
- Mark Bolas
- Doug Bowman
- Fred Brooks
- Edmond Couchot
- James H. Clark
- Doug Church
- Char Davies
- Tom DeFanti
- David Em
- Thomas A. Furness III
- Scott Fisher
- William Gibson
- Morton Heilig
- Eric Howlett
- Myron Krueger
- Knowbotic Research
- Jaron Lanier
- Brenda Laurel
- Michael Naimark
- Randy Pausch
- Mark Pesce
- Warren Robinett
- Dan Sandin

- Susumu Tachi
- Ivan Sutherland

Artists using Virtual Reality Technology

- Rebecca Allen
- Maurice Benayoun
- Sheldon Brown
- Char Davies
- David Em
- Myron Krueger
- Shelley Lake
- Jaron Lanier
- Brenda Laurel
- Michael Naimark
- Jeffrey Shaw
- Nicole Stenger

See also

- AlloSphere
- Augmented reality
- Mediated reality
- Augmented virtuality
- CAVE - Cave Automatic Virtual Environment
- Flight simulation
- Head-mounted display
- Lifelike experience
- Methods of virtual reality
- Omnidirectional treadmill
- Simulated reality
- TreadPort Active Wind Tunnel
- Wired glove
- Virtual Reality Modelling Language
- Virtual worlds
- Virtual globe
- Virtuality Continuum
- Technology and mental health issues

Notes

1. ^ Erik Davis, *Techgnosis: myth, magic and mysticism in the information age*, 1998.
2. '^***Antonin Artaud, "The Alchemical Theater", in* The Theater and its Double*, trans. Mary Caroline Richards, New York: Grove Press, 1958, p. 49, emphasis in original. See also Samuel Weber,* "'The Virtual Reality of Theater': Antonin Artaud", in *Theatricality as Medium*, New York: Fordham University Press, 2004, pp. 277-94.**
3. ^ Garb, Yaakov (Winter 1987). "Virtual reality". *Whole Earth Review* (57): 118ff.
4. ^ Rheingold, Howard (1991). *Virtual Reality* (http://www.rheingold.com/howard/) . ISBN 0-262-68121-8. http://www.rheingold.com/howard/.
5. ^ Gonzales, D. (editor) (1991). "Automation and Robotics for the Space Exploration Initiative: Results from Project Outreach". *[1] (http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA252567&Location=U2&doc=GetTRDoc.pdf)* . **92** (17897): 35.
6. ^ Cline, Mychilo Stephenson (2005). *Power, Madness, & Immortality: the Future of Virtual Reality* (http://books.google.com/?id=7OxbJWzIaVEC&printsec=frontcover&dq=power+madness+and+immortality&q=) . Virtualreality.universityvillagepress.com. http://books.google.com/?id=7OxbJWzIaVEC&printsec=frontcover&dq=power+madness+and+immortality&q=. Retrieved 2009-10-28.
7. ^ http://www.boloji.com/index.cfm?md=Content&sd=Articles&ArticleID=3247
8. ^ "The Future of Virtual Reality with Mychilo Cline » Introduction to the Future of Virtual Reality" (http://virtualreality.universityvillagepress.com/index.php?itemid=25&catid=4) . Virtualreality.universityvillagepress.com. http://virtualreality.universityvillagepress.com/index.php?itemid=25&catid=4. Retrieved 2009-10-28.
9. ^ Castranova, E. (2007). Exodus to the Virtual World: How online fun is changing reality. New York: Palgrave Macmillan.
10. ^ Pimentel, K., & Teixeira, K. (1993). Virtual reality. New York: McGraw-Hill. ISBN 978-0-8306-4065-2
11. ^ "Architecture's Virtual Shake-Up" (http://news.bbc.co.uk/2/hi/programmes/click_online/4385006.stm) Tayfun King, *Click*, BBC World News (2005-10-28)
12. ^ Hemley, Matthew (2008-09-30). "BBC radio launches major cross-station sci-fi season" (http://www.thestage.co.uk/news/newsstory.php/21930/bbc-radio-launches-major-cross-station-sci-fi) . The Stage. http://www.thestage.co.uk/news/newsstory.php/21930/bbc-radio-launches-major-cross-station-sci-fi. Retrieved 2009-04-09.
13. ^ A Dose of Virtual Reality (http://www.businessweek.com/technology/content/jul2006/tc20060725_012342.htm?chan=top+news_top+news)
14. ^ http://www.onr.navy.mil/media/article.asp?ID=86
15. ^ Sandlund M, McDonough S, Häger-Ross C. "Interactive computer play in rehabilitation of children with sensorimotor disorders: a systematic review." (http://www.ncbi.nlm.nih.gov/pubmed/19191834) , *Developmental Medicine & Child Neurology*, v51 n3 p173-179 Mar 2009. Retrieved on 2010-07-22
16. ^ Rapid Marine Prototype -[Marine Prototyping, Yacht Prototyping, Marine Design, Boat Modeling, Design, and Engineering]- » Case Study (http://www.rmpyachts.com/case-study)
17. ^ "CEI : News" (http://legacy.ensight.com/news/ncc.html) . Legacy.ensight.com. http://legacy.ensight.com/news/ncc.html. Retrieved 2009-10-28.
18. ^ "Werkzeug- und Formenbau — Motion Control Systems — Siemens" (http://www.automation.siemens.com/mc/mc-sol/en/977978ba-1d82-47b3-a560-eb298ce89d42/index.aspx) . Automation.siemens.com. http://www.automation.siemens.com/mc/mc-sol/en/977978ba-1d82-47b3-a560-eb298ce89d42/index.aspx. Retrieved 2009-10-28.
19. ^ "Silicone Medical Device Testing" (http://www.dynatekdalta.com/silicone_medical_device_testing.htm) . Dynatek dalta. http://www.dynatekdalta.com

/silicone_medical_device_testing.htm. Retrieved 2009-10-28.
20. ^ "Special Feature: Emerging Technologies | Medical Product Manufacturing News" (http://www.mpmn-digital.com/mpmn/200803/?pg=24) . Mpmn-digital.com. http://www.mpmn-digital.com/mpmn/200803/?pg=24. Retrieved 2009-10-28.
21. ^ Shantesh Hede, Nagraj Huilgol. ""Nano": The new nemesis of cancer Hede S, Huilgol N, - J Can Res Ther" (http://www.cancerjournal.net/article.asp?issn=0973-1482;year=2006;volume=2;issue=4;spage=186;epage=195;aulast=Hede) . Cancerjournal.net. doi:10.4103/0973-1482.29829 (http://dx.doi.org/10.4103%2F0973-1482.29829) . http://www.cancerjournal.net/article.asp?issn=0973-1482;year=2006;volume=2;issue=4;spage=186;epage=195;aulast=Hede. Retrieved 2009-10-28.
22. ^ "IngentaConnect Nanotechnology: Intelligent Design to Treat Complex Disease" (http://www.ingentaconnect.com/content/klu/pham/2006/00000023/00000007/00010284;jsessionid=8tqn6da8a03l0.alice) . Ingentaconnect.com. 2006-06-16. doi:10.1007/s11095-006-0284-8 (http://dx.doi.org/10.1007%2Fs11095-006-0284-8) . http://www.ingentaconnect.com/content/klu/pham/2006/00000023/00000007/00010284;jsessionid=8tqn6da8a03l0.alice. Retrieved 2009-10-28.
23. ^ "Over the Horizon: Potential Impact of Emerging Trends in information and Communication Technology on Disability Policy and Practice" (http://www.ncd.gov/newsroom/publications/2006/emerging_trends.htm) . Ncd.gov. http://www.ncd.gov/newsroom/publications/2006/emerging_trends.htm. Retrieved 2009-10-28.
24. ^ "Nanomedicine - 1(1):67 - Summary" (http://www.futuremedicine.com/doi/abs/10.2217/17435889.1.1.67) . Future Medicine. http://www.futuremedicine.com/doi/abs/10.2217/17435889.1.1.67. Retrieved 2009-10-28.
25. ^ Roudavski, S. (2010). Virtual Environments as Techno-Social Performances: Virtual West Cambridge Case-Study (http://unimelb.academia.edu/documents/0092/6681/roudavski_caadria2010_as_published__with_self-citation_.pdf) , in CAADRIA2010: New Frontiers, the 15th International Conference on Computer Aided Architectural Design Research in Asia, ed. by Bharat Dave, Andrew I-kang Li, Ning Gu and Hyoung-June Park, pp. 477-486

References

- Kulkarni, S.D.; Minor, M.A.; Deaver, M.W.; Pardyjak, E.R.; Hollerbach, J.M.Design, Sensing, and Control of a Scaled Wind Tunnel for Atmospheric Display (http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=5729830) , Mechatronics, IEEE/ASME Transactions on, vol.17, no.4, pp. 635–645, Aug. 2012
- Blascovich, J Bailenson, J. Infinite Reality: Avatars, Eternal Life, New Worlds, and the Dawn of the Virtual Revolution (http://www.infinitereality.org) , Harper Collins, 2011.
- TechCast Article Series, Mateo Fernandez, Metaverse (http://www.techcast.org/Upload/PDFs/633352349732661250_TCMateo.pdf)
- TechCast Article Series, Aaron Druck, When will Virtual Reality become reality? (http://www.techcast.org/Upload/PDFs/061026231112TC%20%20Aaron.pdf)
- Brooks Jr., F. P. (1999). "What's Real About Virtual Reality? (http://www.cs.unc.edu/~brooks/WhatsReal.pdf) ", *IEEE Computer Graphics And Applications*, 19(6), 16
- Burdea, G. and P. Coffet (2003). *Virtual Reality Technology, Second Edition*. Wiley-IEEE Press.
- Goslin, M, and Morie, J. F., (1996). "Virtopia" Emotional experiences in Virtual Environments", *Leonardo*, vol. 29, no. 2, pp. 95–100.
- Oliver Grau, (2003) *Virtual Art: From Illusion to Immersion* (http://leonardo.info/isast/leobooks/books/grau.html) (Leonardo Book Series). Cambridge/Massachusetts: MIT-Press.
- Hayward V, Astley OR, Cruz-Hernandez M, Grant D, Robles-De-La-Torre G. Haptic interfaces and devices (http://www.roblesdelatorre.com/gabriel/VH-OA-MC-DG-GR-04.pdf) . Sensor Review 24(1), pp. 16–29 (2004).
- Hillis, Ken (1999). *Digital Sensations: Space, Identity and Embodiment in Virtual Reality*. University of Minnesota Press, Minneapolis, Minnesota.
- Kalawsky, R. S. (1993). *The Science of Virtual Reality and Virtual Environments: A Technical, Scientific and Engineering Reference on Virtual Environments*, Addison-Wesley, Wokingham, England ; Reading, Massachusetts
- Kelly, K., A. Heilbrun and B. Stacks (1989). "Virtual Reality; an Interview with Jaron Lanier", *Whole Earth Review*, Fall 1989, no. 64, pp. 108(12)
- Klein. D, D. Rensink, H. Freimuth, G.J. Monkman, S. Egersdörfer, H. Böse, & M. Baumann — Modelling the Response of a Tactile Array using an Electrorheological Fluids - *Journal of Physics D: Applied Physics*, vol 37, no. 5, pp794–803, 2004
- Klein. D, H. Freimuth, G.J. Monkman, S. Egersdörfer, A. Meier, H. Böse M. Baumann, H. Ermert & O.T. Bruhns — Electrorheological Tactile Elements. *Mechatronics* - Vol 15, No 7, pp883–897 - Pergamon, September 2005.
- Krueger, M. W. (1991). *Artificial Reality II*, Addison-Wesley, Reading, Massachusetts
- Lanier, J., and F. Biocca (1992). "An Insider's View of the Future of Virtual Reality." *Journal of Communication*, 42(4), 150
- Monkman. G.J. - An Electrorheological Tactile Display - *Presence* (*Journal of Teleoperators and Virtual Environments*) - Vol. 1, issue 2, pp. 219–228, MIT Press, July 1992.
- Monkman. G.J. - 3D Tactile Image Display - *Sensor Review* - Vol 13, issue 2, pp. 27–31, MCB University Press, April 1993.
- Joseph Nechvatal, *Immersive Ideals / Critical Distances*. LAP Lambert Academic Publishing. 2009
- Rheingold, H. (1992). *Virtual Reality*, Simon & Schuster, New York, N.Y.
- Robinett, W. (1994). "Interactivity and Individual Viewpoint in Shared Virtual Worlds: The Big Screen vs. Networked Personal Displays." *Computer Graphics*, 28(2), 127
- Robles-De-La-Torre G. The Importance of the Sense of Touch in Virtual and Real Environments (http://www.roblesdelatorre.com/gabriel/GR-IEEE-MM-2006.pdf) . IEEE Multimedia 13(3), Special issue on Haptic User * Interfaces for Multimedia Systems, pp. 24–30 (2006).
- Roudavski, S. (2010). Virtual Environments as Techno-Social Performances: Virtual West Cambridge Case-Study (http://unimelb.academia.edu/StanislavRoudavski/Papers/166228/Virtual_Environments_as_Situated_Techno-Social_Performances_Virtual_West_Cambridge_Case-Study) , in CAADRIA2010: New Frontiers, the 15th International Conference on Computer Aided Architectural Design Research in Asia, ed. by Bharat Dave, Andrew I-kang Li, Ning Gu and Hyoung-June Park, pp. 477–486
- Slater, M., Usoh, M.(1993). "The Influence of a Virtual Body on Presence in Immersive Virtual Environments" *Virtual Reality International 93*, Proceedings of the Third Annual Conference on Virtual Reality, London, April 1993, pages 34–42. Meckler, 1993
- Stanney, K. M. ed. (2002). *Handbook of Virtual Environments: Design, Implementation, and Applications*. Lawrence Erlbaum Associates, Inc., Mahwah, New Jersey
- Sutherland, I. E. (1965). "The Ultimate Display (http://www.informatik.umu.se/~jwworth/The%20Ultimate%20Display.pdf) ". *Proceedings of IFIP 65*, vol 2, pp. 506–508
- Warwick, K., Gray, J. and Roberts, D. eds. (1993). *Virtual Reality in Engineering*, Peter Peregrinus.
- Zhai, Philip. (1998). *Get Real: A Philosophical adventure in Virtual Reality*, Rowman & Littlefield Publishers, New York and Oxford.

External links

- Mixed Reality Scale (http://commons.wikimedia.org/wiki/File:Mixed_Reality_Scale.png) - Milgram and Kishino's (1994) Virtuality Continuum paraphrase with examples.

Retrieved from "http://en.wikipedia.org/w/index.php?title=Virtual_reality&oldid=521561300"
Categories: Virtual reality | Science fiction themes | User interface techniques | American inventions | Reality by type

External videos

Virtual Reality (http://www.archive.org/details/virtualreali) , *Computer Chronicles* (1992)